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AMERICAN SOCIETY OF ZOOLOGISTS. I.

THE American Morphological Society and the Zoologists of the Central and Western States met in Washington, D. C., in the Medical School Building of the Columbian University, December 30, 1902, and held joint sessions during this and the two succeeding days. A very large number of the members of the societies were in attendance, and an unusually long and interesting program was enjoyed.

During the meeting final action was taken that brought the members of the two above-mentioned societies together under the name of the American Society of Zoologists, with an eastern and a central branch. The constitution adopted looks toward meetings of the society once in three years, to be held alternately in the territories of the two branches. The time and place of the annual meeting of each branch is to be determined by its executive committee.

During the afternoon of the first day a joint session was held with Section F of the American Association for the Advancement of Science, at which papers from the programs of each of the societies were given. Owing to the large number of papers to be presented, further combination did not seem expedient.

The following are brief abstracts of the papers that were presented:

The Atlantic Palolo: Alfred G. Mayer, Museum of the Brooklyn Institute of Arts and Sciences.

The 'Atlantic Palolo' is *Eunice fucata* Ehlers. It is found at the Dry Tortugas, Florida, and lives within disintegrating coral rock or coquina from below low tide level to a depth of at least six fathoms. Its breeding habits are closely similar to those of the well known Pacific Palolo worm (*Eunice viridis*).

The Atlantic Palolo swarms at the surface before sunrise within three days of the day of the last quarter of the moon, between June 29 and July 28. The posterior sexually mature end of the worm breaks away from the anterior end, and swims backwards and upwards to the surface, where it continues to swim backward with great rapidity until about the time of sunrise, when it contracts, casting the genital products out into the water. The anterior part of the worm remains below in the coral rock, and takes no part in the swarm. The worm requires at least two years to attain sexual maturity. There are 57 per cent. of males and 43 per cent. of females. Only sexually mature worms cast off their posterior ends at the time of the swarm. The immature worms are about twelve times as numerous as the mature.

The shock produced by cracking the coral rock acts as a stimulus to produce the drama of the breeding-swarm before the normal date of the swarm. Eggs obtained in this manner are immature and can not be fertilized, even twelve hours before the time of the normal swarm. All of the eggs mature simultaneously within the swimming worms at the time of the normal swarm.

The eggs float in the water, are fertilized and begin to segment soon after extrusion from the worm. The segmentation is total and unequal, the gastrula is formed by epibole, and the larva is telotrochal. The young larvæ swim near the surface, but sink to the bottom upon attaining four pairs of setigerous lobes. The posterior segment of the larva bears a pair of dorsal as well as a pair of ventral cirri. Only the ventral pair of cirri persist in the fully developed worm.

An Aberrant Rotatorian: T. H. Montgomery, Jr., University of Pennsylvania. (Read by title.)

Dimorphic Queens in an American Ant (Lasius latipes Walsh): W. M. Wheeler and J. F. McClendon, University of Texas. (Published in the *Biological Bulletin,* Vol. IV., No. 4, March 1903, pp. 149–163, 3 Figs.)

A colony of *Lasius latipes* observed near Rockford, Illinois, during the nuptial flight (September 17, 1902) was found to contain numerous virgin queens of two different types. One of these (the 'β-female') was the fulvous red, remarkably hairy and flat-legged type, with very short tarsi, that has been heretofore regarded as *the* female of *latipes*. The other ('α-female') was dark brown, less hairy, with much less flattened legs and decidedly longer tarsi. The α-type was also found in material from two nests of *latipes* collected in a very different locality (Colebrook, Connecticut) during August, 1901. No transitions between the two types were observed in any of the nests. The following hypotheses may be advanced to account for the occurrence of the two different queens in the same colony: (1) One of these may be supposed to be the female of a species parasitic on *latipes*. (2) The β-female may represent merely a diseased condition of the α-female. (3) The α-form, in pilosity and structure, is so clearly intermediate between the β-form and the female of *Lasius claviger* Roger as to sug-

gest the possibility of its being a hybrid between *latipes* (β-female) and *claviger* ♂. (4) The α- and β-females represent a new case of dimorphism *sensu stricto* in *L. latipes*. Of these four hypotheses the first and second may be rejected as too improbable to be entertained. The true meaning of the two forms of queens is probably to be sought in the direction of hybridism or of dimorphism *sensu stricto*. Only further observation and experiment can enable us to decide between these interesting alternatives.

Septal Sequence in Corals: J. E. DUERDEN, University of North Carolina.

An account was given of the manner of appearance of the septa in the West Indian coral, *Siderastraea radians* (Pallas), the post-larval development of which has been followed for four months. The results were summarized as follows:

1. The six members of the first cycle of entosepta appear simultaneously, shortly after fixation of the larva, situated within the entocœles of the first cycle of mesenteries.

2. The members of the temporary second cycle, consisting of six exosepta, are developed shortly after the primary cycle of entosepta, within the primary exocœles. The six septa arise simultaneously, or in bilateral pairs in a dorso-ventral order. Later they become bifurcated peripherally, either by the direct extension of the original septum or by the production of separate fragments which subsequently fuse. The bifurcations also appear in a dorso-ventral order.

3. The six members of the permanent second cycle of entosepta arise within the entocœles of the second cycle mesenteries, after these have made their appearance. The two right and left dorsal septa appear first, then the two middle members, and, at a much later period, the two ventral, thus exhibiting a decided dorso-ventrality. In the end they become equal and fuse with the central parts of the second cycle of exosepta previously developed, which now lose their individuality.

4. The twelve members of the temporary third cycle are situated within the exocœles between the primary and secondary pairs of mesenteries, and represent the bifurcated extensions of the six primary exosepta. The original second cycle exosepta thus become the third exocœlic cycle, their place having been taken by the new second cycle of entosepta (law of substitution).

5. The later development of the septa in buds proves that a new third cycle of septa arises in a similar manner, on the appearance of the third cycle mesenteries. New entosepta appear within the entocœles of the third cycle mesenteries, and the bifurcations of the twelve third cycle exosepta become the twenty-four exosepta of the fourth cycle.

6. Exosepta thus appear at each stage in the growth of the corallum, alternating in position and corresponding in number with the entosepta. They never become entosepta, but always constitute the outermost cycle; only the entosepta have any ordinal significance. The adult radial symmetry of the septa is secondary, being derived from structures which appear bilaterally in a dorso-ventral order.

The various stages in development were illustrated by a series of wax models prepared at the American Museum of Natural History, New York.

Iridescent Feathers: R. M. STRONG, Haverford College.

Iridescent feathers from the sides of the neck of the common 'homer' pigeon appear green when the sum of the angles of incidence and reflection is less than 90°, and purple when the sum is more than 90° but less than 140°. The iridescence is

produced by a peculiar form of barbules. There are no attenuated portions, and the individual barbules overlay one another like shingles.

The iridescence is confined to the distal exposed portion of the feather; the same barb may have iridescent barbules distally, and non-iridescent barbules proximally.

The iridescent barbules have much more pigment than the non-iridescent, and this pigment is in the form of spherical granules of melanin, which fill cavities enclosed by a thin transparent layer of keratin. The non-iridescent barbules have the usual rod-shaped pigment granules characteristic of ordinary feathers; these are irregularly distributed in the keratin of the barbule and are often fused more or less completely into small masses.

The spherical pigment granules lying next to the transparent horn layer produce a dispersion of incident light, and the unaided eye receives a mixture of great numbers of the spectra thus formed.

On Anamniote Embryos of the Chick: Frank Rattray Lillie, Hull Zoological Laboratory of the University of Chicago.

The experiments described in this paper consisted, first, in the destruction of the head fold of the amnion between the thirty-third and forty-sixth hours of incubation, with a heated needle; second, a similar operation on the tail-fold of the amnion, immediately after its appearance. If the head fold were completely destroyed without injury to the embryo, the development might proceed up to the age of at least five days in normal manner, except for the complete absence of the amnion back to the hind limbs. In such cases the embryo lay naked on the surface of the blastoderm, to which it was attached in the same manner as a shark's embryo by a very broad somatic and splanchnic umbilicus.

The main conclusions were:

1. The lateral folds of the amnion are in part dependent on the formation of the head fold. In the absence of the latter they are neither so high nor so long as usual, and they do not grow around the embryo. The lateral folds of the amnion must have the support of the head fold to climb up, so to speak, around the body of the embryo.

2. The tail fold of the amnion has only a limited independent capacity of growth; in the absence of the head and lateral folds it does not extend even as far forward as normal.

3. Similarly the head and lateral folds of the amnion have a limited capacity for growth; their backward extension is not simply checked by the advancing tail fold; for, in the absence of the tail fold, these end with a free border in front of the hind limbs.

4. The absence of the amnion has, at least for a time, only a limited effect on the development of the allantois.

5. Inasmuch as the embryo may develop quite normally to the stage of five days without the amnion, it is obvious that the functional significance of the latter must be slight during this period. It yet remains to be determined how far the embryo may develop without the amnion. Certainly there is no good reason for assuming that five days is the limit.

6. There is a certain relation of interdependence between the formation of the amnion and the body wall. In the absence of normal formation of the lateral folds of the amnion, the closure of the somatopleure to form the body wall proceeds more slowly than usual.

The Newly Hatched Larva of Argulus megalops: Chas. B. Wilson, Westfield, Mass., State Normal School.

The most recent classification of the Copepods divides them into three classes:

A. The free-living copepods, Gnathostomata.

B. The parasitic copepods, Siphonostomata.

C. The Branchiura or Argulidæ, also parasitic.

The normal development of the copepods, viz., of the Gnathostomata, is well known to every teacher of zoology, and all have become familiar with the nauplius, metanauplius and cyclops stages in their life history. But the development of the Siphonostomata is still very imperfectly known, and while agreeing in many species with that of the free-living forms, there are frequent modifications resulting from parasitic habits.

The development of the third group, the Argulidæ, has rested until recently upon the study of a single European species, *A. foliaceus,* parasitic upon fresh-water fishes.

But the Argulidæ are found in greater abundance in North and South America and in Africa than in Europe, and are fairly well divided between fresh-water and marine forms.

A recent study of four American species shows that two of them, *A. americanus* and *A. catostomi,* the former a fresh-water species and the latter occurring in both fresh and brackish water, agree almost exactly with *A. foliaceus* in development.

But the life history of the other two species, one, *A. stizostethii,* a fresh-water form, and the other, *A. megalops,* which is marine, is quite different. In both these species the newly hatched larva is almost exactly like the adult. There is no narrowing of the body posteriorly, the abdomen being fully as wide as the thorax and of the same shape as in the adult.

The carapace is somewhat shortened, but even when fully developed it is very meager. The number and arrangement of the appendages are exactly the same as they will always continue.

The form and function of these appendages are also the same, with the single exception of the first maxillipeds, and even here, while the form changes, the function remains constant from the beginning. There is no trace of a temporary locomotor apparatus of any sort or description, as in all other copepod larvæ. We have here, therefore, practically no metamorphosis at all, but a copepod life history which is virtually a direct development, and there is a marked resemblance to the life history of certain orders amongst the insects, such as the Orthoptera, etc.

The Arrangement of the Segmental Muscles in the Geophilidæ, and its Bearing upon the Double Nature of the Segment in the Hexapoda and Chilopoda: L. B. WALTON, Kenyon College.

The arrangement of the dorsal lateral longitudinal muscles in the Geophilidæ corresponds to the division of the segment into an anterior and posterior somite. This, considered in connection with the presence of homologous areas in *Scolopendrella, Campodea, Japyx, Forficula,* etc., together with other evidence, notably the development of the pterygodum (tegula) and wing of the mesothorax in Lepidoptera, the double cross commissures in the embryonic stages of Hexapoda and Chilopoda (as well as Crustacea and Arachnida), the two pairs of metathoracic tracheal openings in *Japyx,* etc., presents a strong case for regarding the segment in the Hexapoda and Chilopoda as composed of two somites, for which the terms *protosomite* and *deutosomite* are proposed.

The 'microthorax' to which Verhoeff has recently called attention as a fourth thoracic segment anterior to the prothorax (Dermaptera) can not be homologized, as he suggests, with the segment bearing the

poison claws in Chilopoda, inasmuch as this segment is composed of a protosomite and deutosomite, the former being homologous with the microthorax (see Geophilidæ). Furthermore, a protosomite homodynamous with the 'microthorax' is present in the Dermaptera on the mesothoracic and metathoracic, as well as on the abdominal, segments. Consequently there is evidence for considering that not only is the thorax in Hexapoda composed of six somites, but that each typical segment in the Hexapoda and Chilopoda (Crustacea and Arachnida?) is composed of two coalesced somites.

The Vertebrate Stomach: J. S. KINGSLEY, Tufts College.

It is usually believed, since the liver in *Amphioxus* directly follows the gill slit region, that the vertebrate stomach and œsophagus were primitively included in the respiratory region. In the embryos of the vertebrates, however, the anlage of the liver follows as closely the last gill slit as it does in *Amphioxus,* and the stomach and gullet are developed, not from the pharyngeal region, but by rapid growth of the short intermediate region. Hence the stomach in the vertebrate is a new formation without its counterpart in the lower chordates.

The Occurrence of Echinoderm Larvæ with Transverse Ciliated Bands: CASWELL GRAVE, Johns Hopkins University. (To be published in the *Biological Bulletin.*)

Serial Order of Segments in the Fore-brain of Three- and Four-week Human Embryos; Comparisons with Lower Forms: SUSANNA PHELPS GAGE, Ithaca, N. Y. (With demonstrations from a series of wax models.)

A three-week human embryo from the collection of Dr. Mall, of Johns Hopkins University, and shown by him and Dr. Bardeen to have two slight anomalies, presents, in the regions of the fore-brain in which the eye and olfactory region are well defined, a third peculiarity. The remnant of the neuropore, the original cephalic opening of the fore-brain, is unusually conspicuous and consists of a thickened union of the epithelium of skin and brain wall. Here arises a furrow extending toward each eye. The conclusion was reached that this point represents approximately the cephalic end of the original neural plate and that as a corollary, by following the original edge of the neural plate, the olfactory region is morphologically caudad of the eye.

A finely preserved and entirely normal human embryo of four weeks prepared by Dr. Buxton, of the Cornell Medical School, gives a similar model, except that the neuropore does not show a thickening. Many other mammalian brains of this stage give similar results.

In a series of chick brains the neuropore was traced to the fifth day, when it was shown to become the recessus opticus.

Summarizing the results of studies in the earlier stages of chick, *Amblystoma* and mouse—the earliest total fold or segment of the fore-brain to appear is the hypophyseal at the cephalic tip of the neural plate; with growth and curving forward of the fore-brain, the eye, second in serial order with relation to the edge of the neural plate, appears; as the eye becomes constricted off the olfactory furrow of the brain appears, entirely dorsal, as shown by His and again (with reference to the edge of the neural plate) following the eye in serial order; next comes the diencephal. From the caudal portion of this original olfactory region arise the folds characteristic of the cerebrum, and from the one furrow of the diencephal the three shown by Minot arise.

Until certain difficult homologies are made in the hypophyseal region of the

brain I hesitate to write a numerical series for the total folds or segments of the forebrain, but with regard to the crucial point in the investigation, the series and the models seem to show conclusively that the eye and its lens are morphologically cephalad of the olfactory region of the brain and of the nasal epithelium.

A Preliminary Account of Studies on the Japanese Frilled Shark, Chlamydoselachus: BASHFORD DEAN, Columbia University.

In view of the archaic features in the adult, he noted as significant in the development of this form the great depth of the zone of yolk nuclei, the absence of external gills, the more nearly terminal position of the anus, the relatively smaller size of the head, the enormous spiracular cleft and the almost typically finfold type of limb. *Chlamydoselachus* has specialized in the line of producing large eggs, the largest indeed among recent animals, ostrich hardly excepted; that it was, however, until recently an egg-depositing shark is apparent from the character of the horn-like capsule (with rudimentary tendriliform processes) which the egg still retains.

The Ependymal Grooves in the Roof of the Diencephalon of Vertebrates: PORTER EDWARD SARGENT.

A cross-section of the brain of any of the lower vertebrates in the region of the posterior commissure reveals a characteristic ependymal structure of conspicuous form and size. In general this consists of thickened and highly differentiated ependyma forming a groove in the roof of the diencephalon, extending from the posterior commissure cephalad to the ganglia habenulæ. This has been mentioned by but four writers, though it occurs in all vertebrates.

In *Petromyzon* there are two grooves located bilaterally on either side of the median plane. Posteriorly they converge and extend about the posterior commissural flexure and above it and are continued cephalad as two lateral horns of the recessus above the commissure. The specialized ependyma of the grooves is sharply marked off from the ependyma, lining the other portions of the ventricle. Nerve fibers from deep-lying cells pass between the cylindrical ependymal cells, and into the ventricular groove. Here they unite to form Reissner's fiber, the anterior divisions of which lie within the groove.

In the gnathostomes there is but one median groove. In the skates, however, the median groove bifurcates at either end, —evidence of the persistence of the bilateral condition. It is obvious that, phylogenetically, the paired grooves of cyclostomes have been crowded toward the median plane by the development of lateral-lying structures and fused to form the one median groove.

In ganoids, teleosts and amphibians the ependymal groove is strictly median and less conspicuous. It assumes a great variety of forms in the different subgroups. In reptiles it is much as in higher selachians, but reduced in size. In birds it is still further reduced. In mammals it has become an inconspicuous structure, which may still be recognized, however, in the thickened ependyma just cephalad of the posterior commissure.

In general this ependymal structure acts as a support for the constituent elements of the fiber of Reissner, and as an 'anchorage' for the fiber as a whole.

On the Individuality of the Maternal and Paternal Chromosomes in the Development of the Hybrid between Fundulus heteroclitus and Menidia notata: WILLIAM J. MOENKHAUS, University of Indiana.

Fundulus heteroclitus and *Menidia*

notata possess chromosomes which are sufficiently different, morphologically, to be distinguished from each other in the cells of the hybrid between the two species. The former has long, straight chromosomes; the latter short, slightly curved ones.

These two kinds of chromosomes retain their individuality during the development of the hybrids to a late cleavage stage, as far as any attempt was made to follow them. During the first two cleavages each kind remains grouped upon the spindle. During the third cleavage this grouping has largely disappeared and the two kinds of chromosomes occur mingled upon the spindle. During the later cleavage stages this bilateral distribution of the chromosomes has altogether disappeared. The two kinds, however, can readily be distinguished, but thoroughly mingled.

Homologies of Anterior Limb: Theo. Gill, Smithsonian Institution.

The homologization of the anterior member of the terrestrial vertebrates with that of fishes is a problem involving a greater diversity of interpretation than any other structure. By the early anatomists (Cuvier, Owen, Stannius) bones which are now universally regarded as parts of the shoulder girdle were designated as the humerus, radius and ulna.

It is contended that *Polypterus* gives us a key to the problem in question, as was urged by the speaker in 1872, 1878 and 1882.

The diverging branches which inclose the flat cartilage with which the actinosts or basal bones of the fin connect are homologues of the radius and ulna; the tubercular process of the coracoid cartilage with which they articulate is the representative of the humerus; the cartilage between the diverging processes is the stuff from which the carpal bones are developed; and the actinosts represent the metacarpals. The nearly similar conclusions of Emory (1887) and Pollard (1892) were much later and somewhat different.

Pollard found the humerus, radius and ulna in the same parts as the speaker. He went to an extreme, however, in the homologization of the intermediate cartilage or 'mesopterygium.' This, he thought, 'forms probably the intermedium and centralia, and the chief foramen in the ossified part represents the intercarpal foramen.'

Inasmuch as *Polypterus* is a very specialized modern form of the great crossopterygian series, and no extinct representatives of its phylum since Devonian times have been discovered, such an extension of homologies is not legitimate and we must be content to recognize the 'mesopterygium,' as a whole, to be homologous with the carpus. This is in accord with the most recent investigations, but still must be confirmed by paleontology.

Homologies of the Centronucleus: Gary N. Calkins, Columbia University.

The Structure of the Ostracoderms: W. Patten, Dartmouth College.

1. In a newly acquired specimen of *Trematapis* the post-orbital and the two pairs of marginal openings are completely closed by a small number of close-fitting polygonal plates. In *Cephalaspis* a single pair of very large marginal openings, closed in a similar manner, has been found. A large marginal opening has also been found in *Thyestes.*

2. In the same specimen of *Trematapis* the dumb-bell-shaped orbital opening is closed by a polished layer of shell, continuous with that of the dorsal shield. Over the lateral ends of the opening the shell is partly broken, but shows clearly that it formed a complete dome-shaped cover to each eye.

3. In *Bothriolepis,* the large median or-

bital plate has a deep pineal pit in its under surface. Two other pits, shallower than the first, are symmetrically placed behind it on the under surface of the semicircular post-orbital plate.

4. The lateral eyes in *Bothriolepis* were placed on short stalks attached to the margin of the orbits by flexible membranes. The lateral end of each stalk was convex, covered with a smooth shell, and could evidently be raised above the orbit or lowered into it.

5. The structure and relations of the 'mental plates' of *Bothriolepis* show that they can not be regarded as either upper or lower jaws of the vertebrate type. If movable at all, they must have moved to and from the median line, bringing their *thickened* and *bent-over* median edges into opposition, like the crushing mandibles of an arthropod.

6. The mouth was very small, round or oval (not a wide transverse opening), located between or just behind the mental plates.

7. The so-called 'semilunars' consist of at least three pieces. Their shape and articulating surfaces show that their posterior margins were freely movable in a *dorso-ventral* direction, like an operculum.

8. Two plates were found supposed to be, one the distal joint, the other a basal plate, of the proximal joint of the pectoral appendage of *Trematapis*.

9. The basal joint of the appendage in *Bothriolepis* contains a short axial skeleton whose expanded distal end shows indications of several fin-like rays.

10. The gill chamber of *Bothriolepis* is a shallow depression on the dorsal surface of the anterior ventrals.

11. In one specimen the gill chamber was partly covered by a folded membrane and it contained indications of gills. The most exposed gill was a flattened body of elongated form. It appeared to be jointed, with a single broad spur, and a fragmentary filament, near its base. The end directed toward the base of the pectoral appendage terminated in a leaf-like expansion.

These facts confirm the author's view that the Ostracoderms can not be classed with the true fishes.

Maturation Changes in the Egg of an Opisthobranch before Deposition: W. M. SMALLWOOD, Syracuse University.

(To be published in the *Bulletin* of the Museum of Comparative Zoology at Harvard College.)

Experiments on Merogony in Nemertine Eggs, with Reference to Cleavage and Localization: EDMUND B. WILSON, Columbia University.

The experiments were performed in order to examine the question of prelocalization of the factors determining the cleavage mosaic in the unsegmented egg. The nemertine egg presents features that allow of its definite orientation from the moment of discharge from the ovary. Egg fragments, obtained before formation of the polar bodies, by shaking the egg to pieces or cutting the eggs individually in various planes with the scalpel, segment exactly like entire eggs of diminished size. Whatever be the plane of section the fragments may, if not too small (one fourth the bulk of the egg or larger), give rise to closed blastulas, which may gastrulate normally and produce dwarf pilidia normal except in size. Isolated blastomeres of the two-cell stage may likewise produce perfect pilidia of half the normal size; isolated one fourth blastomeres may produce dwarf pilidia, never entirely normal, but sometimes very nearly so. In either case the isolated blastomere segments, not like a whole egg, but as if the missing portion of the egg were present. Blastulas

thus arise that are typically open on one side, or in extreme cases form curved or even nearly flat plates; but all these forms may ultimately close, gastrulate and give rise to pilidia, though those arising from the plate-forms appear to be always asymmetrical or otherwise abnormal.

These facts prove that in this egg, which shows a typical spiral mosaic-like cleavage, the form of cleavage is not essential to normal development, since the egg fragment segments as a whole, the isolated blastomere as a fraction, yet both may produce the same result. They prove, further, that the factors determining the cleavage mosaic are not definitely localized in predetermined germ areas before formation of the polar bodies, but become so localized in the period between the beginning of maturation and the completion of the first cleavage. Sections show that during this period a polarized segregation of material takes place. Comparison, especially with the segregation of material occurring at the corresponding period in the eggs of sea-urchins and mollusks, as described by Boveri, Lillie and Conklin, and with the results of Boveri's experiments, leads to the conclusion that this segregation of material is the immediate cause by which the cleavage factors are localized and the form of cleavage determined. Every differential cleavage is probably preceded by analogous segregation of cytoplasmic materials, which not only form an important factor in determining the form of cleavage, but probably are a factor in cell-specification. Cleavage thus plays an important part in differentiation and localization, not as a direct cause, but indirectly as a means of isolation of different materials. The cleavage-mosaic thus becomes a mosaic of such materials and of corresponding developmental tendencies in the individual blastomeres. This mosaic-like character is, however, not due to the preexistence of corresponding areas in the unsegmented egg, but to a progressive process that is essentially epigenetic in character. The primary egg-polarity certainly, and perhaps some other characters, such as bilaterality, preexist in the immature egg, but other cleavage factors are localized by a progressive process in which cytoplasmic movements are a leading factor.

Merogony and Regeneration in Renilla: Edmund B. Wilson, Columbia University.

1. When fertilized eggs of *Renilla* are cut into two or more fragments during the earlier period preceding cleavage, one of the fragments may develop into a dwarf embryo, segmenting at once into eight or ten blastomeres, like a whole egg of diminished size. During the later period, after division of the cleavage nucleus, two or more fragments may develop; but in this case each fragment divides into a smaller number of blastomeres than those produced by an entire egg, the total number being approximately the same as those produced by a whole egg. Cleavage in this egg therefore depends not upon the presence of a certain number of nuclei, but upon the attainment of a critical stage by some other progressive change. The egg fragment may give rise to a planula, and ultimately to a young colony, entirely normal in its structure and proportions, but of diminished size. In this way may be produced dwarf colonies down to about one fourth the bulk of the normal; but, like the full-sized colonies, they do not produce more than a single pair of buds under the conditions in the aquarium. Budding in *Renilla* is, therefore, not dependent upon the amount of material present, but is a process entirely analogous to the formation of organs in the ontogeny of a single individual.

2. As already recorded by Torrey, the young *Renilla* colony exhibits a strongly marked polarity, a new axial polyp being developed after removal of the anterior end, a new peduncle after the removal of the posterior end. After removal of the peduncle posterior to the budding zone it does not ordinarily regenerate a new axial polyp. In a few cases, however, a normal axial polyp was produced at the anterior end of a severed peduncle, and in one case this produced a symmetrical pair of buds in the same position as the primary pair of buds in the normal development. In a single instance a reversal of polarity was obtained, a severed axial polyp regenerating a similar polyp from the basal end, so that a two-headed monster was produced.

3. After oblique section through the budding zone a process of remolding takes place in such a manner as to cause one of the lateral buds to occupy the position formerly occupied by the axial polyp, while the wound entirely heals. A new axis is thus apparently established. At a later period, however, this initial remolding is overcome by a process of regeneration, a new axial polyp developing at the point corresponding to the position of the original one, so that the lateral polyp is again displaced to its original position at the side. This indicates that the persons of the colony are definitely specified and are not interchangeable.

The same result is given by operations in which the peduncle is removed, together with a single small lateral bud. In such cases the remaining bud remains entirely stationary in development, or may even disappear, while a new axial polyp of full size is regenerated from the cut surface. In one case where the lateral bud remained, a corresponding bud was formed on the opposite side so as again to produce the condition of the primitive colony with a single pair of buds.

4. These observations show that the individuality of the buds in *Renilla* has become wholly subordinated to that of the colony, which develops from the egg or regenerates lost parts in essentially the same way as an individual in the ordinary sense.

Notes on the Artificial Reversal of Asymmetry in Alpheus: EDMUND B. WILSON, Columbia University.

As Przribram has described, the removal of the large or hammer-chela in *Alpheus heterochelis* causes the remaining small chela to be transformed at the first or second moult into a hammer-chela of the large type, a chela of the small type being regenerated in place of the large one that has been removed. If after removal of the hammer-chela the nerve of the small chela be severed at the base, this transformation does not take place or is incomplete.

Comparison shows that the small chela of the female conforms closely to the early larval type, while that of the male is more modified in a direction toward the type of the hammer-chela. Since in the young larva both chelæ are alike (Brooks and Herrick) and correspond in type to the female small chela, the latter may be regarded as an embryonic type in a state of arrested development, while the male small chela represents a somewhat more advanced state. In both cases the development of the small chela is held in check by the presence of the large one, the inequality constituting an equilibrium characteristic of the species. Removal of the large chela releases the development of the small one, and at the same time reverses the asymmetry of material. Regeneration then proceeds along the same lines as in the normal development until the adult equilibrium is restored, but in a reversed condition. In this case, therefore, an appa-

rently adaptive regenerative process of high utility to the animal seems to require for its explanation, in the female at least, no special regulative factors that differ from those concerned in the normal development.

Instincts of the Lepidoptera: A. G. Mayer, Museum of the Brooklyn Institute of Arts and Sciences.

On the Color-patterns of Certain Bermuda Fishes: C. L. Bristol, New York University.

During the six seasons, June to August, the writer has collected large numbers of living fishes in Bermuda and sent them to the New York Aquarium, where they have been placed on exhibition, and has made many observations upon them in their natural surroundings and in confinement. Taken together they comprise the principal fishes of the West Indies and are fairly representative of the coral-reef fishes. The following conclusions are preliminary only, and may serve only as a starting point for more extended study.

Three factors are correlated with the habits to produce the specific appearance of the various species.

In general, (*a*) the scale of coloration is high, (*b*) the patterns range from simple to compex, and (*c*) the power to change color varies from almost *nil* to an astonishing degree.

1. *Warning Coloration.* — Fishes with high color, simple patterns and little if any color-change are inedible, *i. e.*, disagreeable, or are covered with harsh scales and have sharp fin rays. *E. g.*, the green parrot fish, the squirrel.

2. *Protective Coloration.*—The scale of coloration is not so high; the pattern is complex and the color-change is great. *E. g.*, the 'four-eyed' fish (*Chætodon*), the blue parrot, the hind.

3. Midway between these is a third group in which the three factors are more nearly balanced between the two extremes and in which some offensive or defensive device is added. The color is medium, the pattern is not complex and the range of color change is less than in the second group. This group is illustrated by the angel fish and the surgeons.

Lymphatics of the Lung of Necturus: W. S. Miller.

The Brain of the Larva of Echinus esculentus: E. W. MacBride, McGill University.

In larvæ of the common British sea-urchin, *Echinus esculentus,* about the twenty-first day after fertilization, there is visible at the extreme front end of the body a shallow pit lined by ectoderm cells which are thicker than those covering the general surface. When sections are made through the pit and examined with a Zeiss apochromatic immersion lens, a very thin layer of nervous fibrils is seen lying at the base of the thickened ectoderm cells. These fibrils are proved to be nervous by the exact similarity in appearance and reaction to osmic acid, between them and the first fibrils which appear in the rudiment of the adult nervous system. The pit does not form a part of the longitudinal ciliated band, and hence can not be compared to the apical thickening observed by Théel* in the larvæ of *Echinocyamus pusillus,* which becomes incorporated with the ciliated band. It does, however, correspond exactly in position with the thickening described by Field† in the larva of *Asterias vulgaris,* and with the apical plate of neuro-epithelium which is one of the character-

* Théel, 'The Development of Echinocyamus pusillus,' *Proc. Royal Soc. Upsala,* 1892.

† Field, 'The Larva of Asterias vulgaris,' *Quart. Journ. Micr. Sc.,* 1891.

istics of the *Tornaria* larva. Field was not able to detect any fibrils associated with the thickening in the larvæ he examined, but in the larva of *Echinus esculentus* the layer of fibrils above described goes on increasing in thickness as growth proceeds, until just before the metamorphosis it is as thick as the cells themselves, and intermixed with the fibrils are a few minute ganglion cells of the type commonly found in the nervous system of echinoderma. The discovery of this brain removes a great difficulty in the way of comparing the larvæ of echinoderma with the *Tornaria* larva.

The Effect of Lithium Chloride on the Development of the Frog's Egg: T. H. MORGAN, Bryn Mawr College.

In 1894 I tried the effect of several solutions on the development of the frog's egg; amongst others, solutions of several halogen salts. The main result was to produce spina bifida embryos. A year later Hertwig extended the same experiment, and in 1896 Gurwitsch also described the effect of a number of substances, including lithium chloride, on the development of the frog's egg. The interpretation given by Gurwitsch of the kind of embryos produced by solutions of this salt did not appear to me to fit in with results that I had obtained in other ways. This led me to take up the subject again. Amongst the different kinds of embryos that I obtained there were some similar to those described by Gurwitsch. I shall not, however, describe here embryos of this sort, nor discuss their interpretation.* Amongst the embryos there was a characteristic kind, different from any that have been yet obtained. It is these that I shall now describe.

* Madame Rondeau-Luzeau has more recently (1902) described the effect of lithium chloride on the frog's egg.

Eggs in the two- and four-cell stages, as well as in early and later segmentation stages, were put into fresh water to which 0.4, 0.5, 0.6 per cent. lithium chloride had been added. The best results were obtained from eggs in the late segmentation stages.

There appears after several days in the eggs in the solutions an invagination on one side of the egg. A little later a crescentic depression or even a complete ring appears high up on the egg, and the whole black hemisphere seems to be sinking into the interior of the egg, with the crescent or ring closing over the top of the egg. At the same time a slate-colored band appears in the region between the first invagination and the ring above. This band is much broader on that side of the egg where the invagination first appeared. Along the middle of this area a darker line runs vertically upward. I may say at once that this line indicates the position of the notochord, and the slate-colored band is a layer of endoderm cells, one cell deep. Beneath it are the two mesoblastic sheets, one on each side of the notochord.

Sections of these eggs show clearly what has taken place. The top of the egg that disappeared into the interior forms inside of the egg the medullary plate, bent double on itself. It lies, therefore, in the middle of the egg. As the whole ectoderm has turned in, the yolk-cells from the sides have been drawn upward, where they form the single layer of cells that cover the slate-colored area. Beneath this lies on each side of the notochord a thick mesoblastic sheet.

The first invagination (archenteron) sinks deep into the egg—possibly it is continued by the yolk cells drawing apart. A narrow archenteron is formed in this way, that bends under the medullary plate in the interior of the egg. The notochord,

that lies just below the dark groove in the middle of the slate-colored area continues into the egg along the dorsal wall of the archenteron.

These embryos do not appear to be able to develop much beyond this stage, although they may remain alive for several days longer in the solutions. The interpretation of this peculiar method of development seems to be as follows: The cells of the upper hemisphere appear to have been prevented from growing down at the sides, and, after the blastopore has been formed, from covering over the lower hemisphere. The medullary plate develops from the inner wall of the cap of ectoderm that has been turned into the interior of the egg. As this upper region sinks in, the surface yolk cells below the equator of the egg are drawn upwards, as has been said, and produce the slate-colored band. They may be supposed to represent, in a general way, the dorsal wall of the archenteron of the normal egg, which is now spread out on the surface of the egg. This comparison needs, however, several important limitations, which I can not enter into here. The rest of the archenteron is represented by the long but very narrow tube leading inwards from the blastopore. Thus the embryo is, in a sense, inverted, the nervous system being in the interior of the egg, and yolk cells almost completely covering the surface. The result is due in all probability, in part, to changes in the osmotic conditions in the egg. I hope soon to describe, with figures, these embryos, as well as other kinds produced in the same solutions.

Experiments on the Origin of the Cleavage Centrosomes: E. G. Conklin, University of Pennsylvania. (To be published in the *Biological Bulletin.*)

On the Erosion of the Shell of Littorina litorea: R. P. Bigelow and Eleanor P. Rathbun.

The investigations of Morse and Ganong have shown that *Littorina litorea* has become established on our coast within the last half century, and Bumpus has made a statistical study of the species, from which important conclusions were drawn as to the changes of type and variability resulting from this change of environment.

Therefore, this species seemed to be a favorable one upon which to make a determination of the present rate and direction of natural selection. But it seemed wise to determine first how far erosion might tend to falsify the results.

Sections of fresh shells were made by the method used in sectioning minerals, and the chief results are given in the following table.

Stage.	Length of Shell.	Estimated Reduction.			Increase of Ventricosity.
	mm.	mm.	Per. cent. of total length.	Per cent. of stage 1.	Per. cent. of total length.
1.	2.87	0	0	0	0
2.	5.0	0.25	5.0	8.7	—
3.	12.5	0.6	4.8	20.9	4
4.	17.0	1.33	7.8	46.3	5–6

The section shows that erosion has begun in stage 1, but, as that is the smallest shell that it was possible to cut, the erosion is assumed to be zero for purpose of comparison with the later stages.

These observations are not sufficiently numerous to have a statistical value, but they are sufficient to show that the factor of erosion must be considered before any conclusions can be drawn from a statistical study of the dimensions of shells of this species, and to suggest that it would be well to make sections and study carefully the extent of erosion before publishing the results of measurements of any other gasteropod shell.

The Variations of Some Acquired Characters: R. P. BIGELOW and ELEANOR P. RATHBUN.

The discussion of the phenomena of coadaptation has emphasized the view that success of the individual in the struggle for existence may depend as much upon favorable individually acquired modifications as upon congenital variations. The present state of any species, then, is the result of selection acting on both (1) variations and (2) modifications, tending to eliminate the unfit of both indiscriminately, and to spare the best fitted. In order to understand the effect of this process upon the species as a whole it is necessary to know the types and the distributions of the deviations of the selected characters.

Much has been done to supply data in regard to congenital variations by workers following the methods perfected by Pearson. But heretofore this new means of investigating biological phenomena has not been employed in the study of acquired modifications. The present investigation was undertaken as a preliminary reconnaissance of this new field.

The material chosen for study is obtained from the records of the first-year students of the Boston Normal School of Gymnastics, kindly furnished to the authors by the director, Miss Amy M. Homans. The records selected are those of women who have completed the first year of training and whose measurements have been recorded at the beginning of the year and at the end of the eight months. The average age is 23.6 years, but nearly half of the students are between 19 and 22 years of age. In most of the series of measurements we were able to obtain from 300 to 330 individual records. The students come from various parts of the country, and upon entering the school are introduced into a new environment, which is very uniform, the gymnastic and mental training being the same for all students.

The questions that the authors have sought to answer are: (1) Is there a change of type, and of what extent? (2) What is the effect of training upon the variability of the group? (3) What is the relation between capacity for modification and initial position in the scale? and (4) what relation exists between amount of modification and length of time of training? The first question has already been answered partially by Beyer, Enebuske, and Wood; the others have not been answered before.

Five series of measurements have been studied, viz., (1) girth of left forearm, (2) lung capacity, (3) mobility of chest, *i. e.*, difference between girth at rest and girth at forced inspiration, (4) strength-weight index, *i. e.*, all the strength tests added together and divided by the weight, and (5) strength of legs.

As was to be expected, the value of the mean of each of these characters was found to have become greater after training. The difference is best expressed in terms of the initial standard deviation. The smallest change was in the girth of the left forearm, amounting to 22.6 per cent. of the standard deviation; the greatest was in the strength of legs, 162.5 per cent. The other changes of type were: lung capacity, 40 per cent.; mobility of chest, 55.5 per cent., and strength-weight index, 101.2 per cent.

The variability was found not to have changed to a sensible degree in three of the series, while in two others there was an increase. For the strength-weight index this was 11.25 per cent. of the original standard deviation, and for the strength of legs, 18.33 per cent. It will be noticed that these two series are the same ones in which the increase of the mean exceeds the magnitude of the standard deviation. The frequency curves are all slightly skew at

first in a positive direction, and after training show a little increase of positive asymmetry, with the exception of the strength-weight index, in which the skewness decreases to nearly perfect symmetry.

The relation between capacity for modification and the initial position in the scale can be determined only after calculation of coefficients of correlation, and for this purpose correlation tables are now being constructed.

The relation between the amount of modification and the length of time of training has been studied in only one series of measurements, that of the strength of legs. The measurements were plotted for every second month, that is, October, December, February, April and June. The magnitude of the mean was found to increase during each succeeding period, rapidly at first and then more and more slowly. The increase amounted during the first period to 20 kilos, during the second to 8.8 kilos, third to 6.4 kilos, and fourth to 0.37 kilos.

Gilman A. Drew,
Secretary (Eastern Branch).
University of Maine.

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*Some Fundamental Discoveries in Mathematics.**

The oldest extensive work on mathematics which has been deciphered was written by an Egyptian named Ahmes between 1700 and 2000 B.C. It bears the following title: 'Direction for obtaining a knowledge of all dark things * * * all secrets which are contained in the things,' and claims to be modeled after writings which were then old. The first part is devoted to a table in which every fraction whose numerator is 2 and whose denominator is any odd number from 5 to 99 is resolved into the sum of fractions with unity as a common numerator. The following are examples:

$$\tfrac{2}{5} = \tfrac{1}{3} + \tfrac{1}{15},\ \tfrac{2}{7} = \tfrac{1}{4} + \tfrac{1}{28},\ \tfrac{2}{99} = \tfrac{1}{72} + \tfrac{1}{88} + \tfrac{1}{792}.$$

As this table is constructed according to no general rule, it is probable that it is a collection of results obtained by mathematicians during a long period of years. In fact some of these numbers are found in a mathematical papyrus which is many hundred years older than the work of Ahmes. This table, therefore, furnishes one of the many evidences of the fact that the early development of mathematics is largely based upon experiments. Comprehensive rules and theorems are a much later product.

From a modern point of view it might be said that the theory of arithmetical progression marked the highest point reached by Ahmes in arithmetic. He solves linear algebraic equations involving one unknown and considers the area of a circle equivalent to a square whose side is eight ninths of the diameter. This is equivalent to calling $\pi = 3.1605$, which is a much closer approximation than many later nations employed.* To find the area of an isosceles triangle he multiplied the base by half of one of the equal sides instead of by half the altitude. This inaccuracy seems to be due to the fact that the Egyptians did not know how to extract the square root of a number, and hence they could not find the exact area of such a triangle from its sides.

While the work of Ahmes is of the greatest interest to the mathematical historian, yet it contains few facts of sufficient generality or beauty to be classed among the fundamental discoveries in mathematics. It emphasizes rules rather than thought. In fact, it is practically confined to problems and answers, with the verifications of

* Read before the Science Association of Stanford University, November 5, 1902.

* Cf. I. Kings, ch. 7, v. 23 and II. Chronicles, ch. 4, v. 2.